भारतीय मानक

IS 9142 (Part 2) : 2018

Indian Standard

कंक्रीट के लिए हल्के भार वाला कृत्रिम मिलावा — विशिष्टि

भाग 2 सिंटरित फ्लाई एश का मोटा मिलावा

(पहला पुनरीक्षण)

Artificial Lightweight Aggregate for Concrete — Specification

Part 2 Sintered Fly Ash Coarse Aggregate

(First Revision)

ICS 91.100.30

© BIS 2018

भारतीय मानक ब्यूरो
BUREAU OF INDIAN STANDARDS
मानक भवन, 9 बहादुरशाह ज़फर मार्ग, नई दिल्ली – 110002
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI-110002
www.bis.gov.in www.standardsbis.in

September 2018 **Price Group 6**

Cement and Concrete Sectional Committee, CED 02

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Cement and Concrete Sectional Committee had been approved by the Civil Engineering Division Council.

One of the methods of producing lightweight concrete is by using lightweight aggregates. The essential characteristic of lightweight aggregate is its high porosity which results in a low apparent specific gravity. Some lightweight aggregates occur naturally and others are manufactured.

This standard was first published in 1979. This revision has been brought out to incorporate the modifications found necessary in the light of experience gained in its use and also to bring it in line with the latest development on the subject.

In this revision, the standard is being brought out in two parts. The other part in the series is:

Part 1 For concrete masonry blocks and for applications other than for structural concrete

This standard (Part 2) specifies the requirements of sintered fly ash lightweight aggregates. The sintered fly ash lightweight aggregates covered in this standard are used for manufacture of structural concrete for non-wearing surfaces. For clarification regarding wearing/non-wearing surfaces, a reference may be made to IS 383 : 2016 'Coarse and fine aggregate for concrete — Specification (*third revision*)'. The structural concrete mentioned in this standard is to be construed as plain and reinforced concrete.

The prospect of using sintered fly ash aggregate for non-masonry purposes also is a new endeavour, and hence a general guideline for the same has been provided at Annex A.

This standard contains **11.1** which call for agreement between the purchaser and the manufacturer.

The composition of the Committee responsible for the formulation of this standard is given in Annex B.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that specified value in this standard.

Indian Standard

ARTIFICIAL LIGHTWEIGHT AGGREGATE FOR CONCRETE — SPECIFICATION

PART 2 SINTERED FLY ASH COARSE AGGREGATE

(First Revision)

1 SCOPE

This standard covers the requirements of sintered fly ash lightweight coarse aggregate for use in structural concrete for non-wearing surfaces in which the prime consideration is reducing the density of concrete.

2 REFERENCES

The standards given below contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
269 : 2015	Ordinary Portland cement — Specification (*sixth revision*)
383 : 2016	Coarse and fine aggregate for concrete — Specification (*third revision*)
456 : 2000	Plain and reinforced concrete — Code of practice (*fourth revision*)
516 : 1959	Methods of test for strength of concrete
1199 (Part 5) : 2018	Method of sampling and analysis of fresh concrete: Part 5 Making and curing of test specimens (*first revision*)
2386	Methods of test for aggregates for concrete
(Part 1) : 1963	Particle size and shape
(Part 2) : 1963	Estimation of deleterious materials and organic impurities
(Part 3) : 1963	Specific gravity, density, voids, absorption and bulking
(Part 4) : 1963	Mechanical properties
(Part 5) : 1963	Soundness
2430 : 1986	Methods for sampling of aggregates for concrete (*first revision*)
3812 (Part 1) : 2013	Pulverized fuel ash — Specification: Part 1 For use as pozzolana in cement, cement mortar and concrete
4032 : 1985	Method of chemical analysis of hydraulic cement (*first revision*)
4905 : 2015/ ISO 24153 : 2009	Random sampling and randomization procedures (*first revision*)
5816 : 1999	Method of test splitting tensile strength of concrete (*first revision*)

3 GENERAL CHARACTERISTICS

3.1 This standard covers the requirements of sintered fly ash lightweight coarse aggregates intended for use in structural concrete for non-wearing surfaces.

3.2 The aggregate shall be composed predominately of lightweight cellular structure.

4 GRADING

The coarse aggregate shall be supplied either single-sized or graded sintered fly ash lightweight coarse aggregate. The grading of the sintered fly ash lightweight coarse aggregate, that is, its particle size distribution, shall conform to the requirements shown in Table 1.

Table 1 Grading Requirements for Sintered Fly Ash Lightweight Coarse Aggregate

(*Clause* 4)

Sl No.	IS Sieve Designation	Percentage Passing for Single-Sized Coarse Aggregate of Nominal Size				Percentage Passing for Graded Coarse Aggregate of Nominal Size		
		20 mm	16 mm	12.5 mm	10 mm	20 mm	16 mm	12.5 mm
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
i)	40 mm	100	—	—	—	100	—	—
ii)	20 mm	85-100	100	—	—	90-100	100	100
iii)	16 mm	—	85-100	100	—	—	90-100	—
iv)	12.5 mm	—	—	85-100	100	—	—	90-100
v)	10 mm	0-20	0-30	0-45	85-100	25-55	30-70	40-85
vi)	4.75 mm	0-5	0-5	0-10	0-20	0-10	0-10	0-10
vii)	2.36 mm	—	—	—	0-5	—	—	—

5 BULK DENSITY

5.1 The dry loose bulk density of sintered fly ash lightweight coarse aggregate shall not exceed 950 kg/m^3.

5.2 Uniformity of Mass

The bulk density of successive supplies of sintered fly ash lightweight coarse aggregate shall not differ by more than 10 percent from that of the sample submitted for acceptance tests.

6 DELETERIOUS SUBSTANCES

6.1 The fly ash for sintering shall conform to the chemical requirements as given Table 1 of IS 3812 (Part 1).

6.2 Sintered fly ash lightweight aggregate shall not contain excessive amounts of deleterious substances, as determined by the limits described in **6.3** to **6.5.**

6.3 Organic Impurities

Sintered fly ash artificial lightweight aggregate, upon being subjected to the test for organic impurities that produce a colour darker than the standard colour shall be rejected, unless it can be demonstrated that the discoloration is due to small quantities of materials not harmful to the concrete.

6.4 Clay Lumps

The amount of clay lumps in sintered fly ash lightweight aggregate shall not exceed 1.0 percent of its dry mass.

6.5 Loss on Ignition

Loss on ignition of sintered fly ash lightweight aggregate shall not exceed 5.0 percent of its dry mass.

7 CONCRETE MAKING PROPERTIES

7.1 Water Absorption

The water absorption of sintered fly ash lightweight aggregate shall not be more than 18.0 percent of its own mass.

7.2 Sulphate Content

The sulphate content of sintered fly ash lightweight coarse aggregate shall not be more the 1.0 percent when expressed as sulphuric anhydride (SO_3) by mass. However, it is to be ensured that the total limit of sulphate in concrete does not exceed the permissible limits of total sulphate in concrete as given in the IS 456.

7.3 Mechanical Properties

7.3.1 *Crushing Value*

The aggregate crushing value, when tested in accordance with the method specified in IS 2386 (Part 4) shall not exceed 45 percent.

7.3.2 *Impact Value*

As an alternative to **7.3.1**, the aggregate impact value, when tested in accordance with the method specified in IS 2386 (Part 4) shall not exceed 40 percent by weight.

7.3.3 *Abrasion Value*

The abrasion value of aggregates, when tested in accordance with the method specified in IS 2386 (Part 4) using Los Angeles abrasion machine, shall not exceed 40 percent.

7.4 Soundness

The soundness of aggregates, when tested in accordance with IS 2386 (Part 5) the average loss of weight after 5 cycles shall not exceed the following:

a) 12 percent when tested with sodium sulphate (Na_2SO_4); and

b) 18 percent when tested with magnesium sulphate ($MgSO_4$).

7.5 Drying Shrinkage

The drying shrinkage of concrete specimens prepared and tested in accordance with **8.7** shall not exceed 0.03 percent.

8 METHODS OF SAMPLING AND TESTING FOR LIGHTWEIGHT AGGREGATE

8.1 Sampling

The sampling of sintered fly ash lightweight coarse aggregate shall be done in accordance with IS 2430.

8.2 Grading

Grading of sample of sintered fly ash lightweight coarse aggregate shall be done in accordance with the provisions given in IS 2386 (Part 1).

8.3 Bulk Density (Loose)

The sintered fly ash lightweight aggregate shall be tested in oven-dry conditions according to the requirements given in IS 2386 (Part 3) .

8.4 Organic Impurities

The aggregate shall be tested in accordance with IS 2386 (Part 2).

8.5 Clay Lumps

Clay lumps in aggregate shall be determined as described in IS 2386 (Part 2).

8.6 Loss on Ignition

Loss on ignition of the aggregate shall be determined on crushed sample passing 150 microns IS sieve by the method described in **4.2** of IS 4032, as per procedure applicable for cement.

NOTE — For the purpose of testing, wherever reference to cement has been made in IS 4032, it may be read as aggregate.

8.7 Drying Shrinkage

The drying shrinkage of concrete shall be determined as follows.

8.7.1 *Casting of Specimen*

Prepare a concrete mix proportion of one part ordinary Portland cement conforming to IS 269 to six parts combined aggregates (2 parts of natural fine aggregate conforming to Zone II of IS 383 and 4 parts of graded lightweight coarse aggregate conforming to grading as given in Table 1) measured by dry loose volume. Adjust the water content so as to produce a slump of 50 to 100 mm. Thoroughly, consolidate the concrete in steel prism bar molds (75 mm × 75 mm × 300 mm). The surface of the concrete shall be steel-troweled.

NOTE — The lightweight coarse aggregate shall be in saturated surface dry condition prior to mixing in concrete.

8.7.2 *Curing and Testing of Specimen*

The specimen shall be cured and tested in accordance with procedure given in IS 1199 (Part 5).

8.7.3 *Report*

Report the change in length as the drying shrinkage of the specimen. Report the average drying shrinkage of three specimens as the drying shrinkage of concrete.

8.8 Sulphate Content

The sulphate content of the aggregate shall be determined on crushed sample passing 50 microns IS sieve by the method described in **4.9** of IS 4032, as per procedure applicable for cement.

NOTE — For the purpose of testing, wherever reference to cement has been made in IS 4032, it may be read as aggregate.

9 REJECTION

Material that fails to conform to the requirement of this specification shall be subject to rejection. The reason of rejection shall be reported to the producer or the supplier promptly and in writing.

10 SUPPLIER'S CERTIFICATE AND COST OF TESTS

10.1 The supplier shall satisfy himself that the material complies with the requirements of this standard and, if requested, shall supply a certificate to this effect to the purchaser.

10.2 If the purchaser requires independent tests to be made, the sample for such tests shall be taken before or immediately after delivery, according to the option of the purchaser and the tests carried out in accordance with this standard and on the written instructions of the purchaser.

10.3 The supplier shall supply free of charge the material required for tests.

10.4 The cost of tests carried out under **10.2** shall be borne by:

a) The supplier, if the results show that the materials does not comply with this standard; and

b) The purchaser, if the results show that the material complies with this standard.

11 DELIVERY

11.1 Supplies of aggregate may be made in bulk in suitable quantities mutually agreed upon between the purchaser and the supplier. Where so required by the purchaser, the aggregate may be supplied in bags (jute, jute-laminated, polyethylene lined or as may be mutually agreed to between the purchaser and the supplier) bearing the net quantity (may be 15 kg, 30 kg, 300 kg, 600 kg or as agreed to between the purchaser and the supplier). The tolerance on the quantity of aggregate in each bag or consignment shall be as per **11.2** unless mutually agreed upon between the purchaser and the supplier.

11.2 Tolerance Requirements for the Quantity of Aggregate Packed in Bags

11.2.1 The average of net quantity of aggregate packed in bags at the plant in a sample shall be equal to or more than 25 kg, 50 kg, 300 kg, 600 kg, etc, as applicable. The number of bags in a sample shall be as given below:

Batch Size (1)	*Sample Size* (2)
100 to 150	20
151 to 280	32
281 to 500	50
501 to 1 200	80
1 201 to 3 200	125
3 201 and over	200

The bags in a sample shall be selected at random (*see* IS 4905).

11.2.2 The number of bags in a sample showing a minus error greater than 2 percent of the specified net quantity shall be not more than 5 percent of the bags in the sample. Also the minus error in none of such bags in the sample shall exceed 4 percent of the specified net quantity of aggregate in the bag.

11.2.3 In case of a wagon or truck load of 5 to 25 t, the overall tolerance on net quantity of aggregate shall be 0 to + 0.5 percent.

12 MARKING

12.1 Each consignment/bag of aggregate shall be legibly and indelibly marked with the following information:

a) Manufacturer’s name and his registered trade-mark, if any;
b) Net quantity, in kg;
c) Words ‘Use no Hooks’ on the bags;
d) Batch/control unit number;
e) Address of the manufacturer;
f) Month and year of consignment/packing;
g) The words ‘Sintered Fly Ash Coarse Aggregate’; and
h) The nominal size along with the words, ‘Single sized’ or ‘Graded’.

12.2 Similar information shall be provided in the delivery advices accompanying the shipment of aggregate in bulk (*see* **12.3**).

12.3 BIS Certification Marking

The aggregate may also be marked with the Standard Mark.

12.3.1 The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations made thereunder. The details of the conditions under which the licence for use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

ANNEX A

(*Foreword*)

GUIDELINES FOR USE OF SINTERED FLY ASH LIGHTWEIGHT COARSE AGGREGATE IN STRUCTURAL CONCRETE

A-0 The structural grade sintered fly ash lightweight coarse aggregate are produced by pelletization and sintering done at temperature range of 1 100 to 1 300°C. The burning of carbon in the pallets and loss of moisture creates a cellular structure bonded together by the fusion of fine ash particle.

Structural lightweight-aggregate concrete (SLC) is made with structural lightweight aggregate conforming to this standard. The concrete has density less than 2 000 kg/m^3 and consists entirely of lightweight aggregate or a combination of lightweight and normal weight aggregate.

These guidelines may be followed for design of structural grade sintered fly ash lightweight concrete made with lightweight coarse aggregate and normal weight fine aggregate

NOTE — The combination of lightweight fine aggregate and normal weight fine aggregate together in concrete is not usually recommended.

A-1 MECHANICAL PROPERTIES OF SINTERED FLY ASH LIGHTWEIGHT AGGREGATE CONCRETE

A-1.1 Lightweight concrete up to grade M35 and below may be made and used for structural use in non-wearing surfaces.

A-1.2 There is normally little gain of strength beyond 28 days. The design should be based on 28 days characteristic strength of concrete.

A-1.3 The flexural and splitting tensile strengths shall be obtained as described in IS 516 and IS 5816, respectively. When the designer wishes to use an estimate of the tensile strength from the compressive strength, the following formula may be used:

$$\text{Flexural strength, } f_{cr} = 0.6 \sqrt{f_{ck}} \text{ N/mm}^2$$

Where, f_{ck} is the characteristic cube compressive strength of concrete in N/mm^2.

A-1.4 The modulus of elasticity is primarily influenced by the elastic properties of the aggregate. The modulus of elasticity of concrete can be assumed as follows:

$$E_c = 3\,000 \sqrt{f_{ck}}$$

Where E_c is the short term static modulus of elasticity in N/mm^2. Actual measured values may differ by ± 20 percent from the values obtained from the above expression.

A-2 DURABILITY OF LIGHTWEIGHT AGGREGATE CONCRETE

A-2.1 One of the main characteristics influencing the durability of concrete is its permeability to the ingress of water, oxygen, carbon dioxide, chloride, sulphate and other potentially deleterious substances. The factors influencing durability include:

a) Environment;
b) Cover to embedded steel;
c) Type and quality of constituent materials;
d) Cement content and water/cement ratio of the concrete;
e) Workmanship, to obtain full compaction and efficient curing; and
f) Shape and size of the member.

A-2.2 The general environment to which the concrete will be exposed during its working life is classified into five levels of severity, that is, mild, moderate, severe, very severe and extreme as described in IS 456. Use of lightweight concrete is not recommended in very severe and extreme exposure conditions.

A-2.3 Exposure to Sulphate Attack

Exposure classification with respect to sulphate attack and recommendations for the type of cement, minimum cement content and other precautions in case of very high sulphate concentrations in class 5, which are required at different sulphate concentrations in near-neutral ground water having *p*H of 6 to 9 shall be as per IS 456. However, the maximum free water/cement ratio shall be further low by 0.05 in all classes.

A-2.4 Requirement of Concrete Cover

The protection of the steel in concrete against corrosion depends upon an adequate thickness of good quality concrete. The nominal cover to the reinforcement to meet the durability requirement in case of lightweight concrete shall be increased by 10 mm over and above as provided in Table 16 of IS 456.

A-2.5 Concrete Mix Proportions

The free water-cement ratio is an important factor in governing the durability of concrete and should always as low as possible. Appropriate values for minimum cement content given in Table 5 of IS 456 for different exposure conditions shall also be applicable for lightweight concrete. However, the maximum free water-cement ratio given in Table 5 of IS 456 shall be further reduced by 0.05 in all exposure classes.

A-2.6 Maximum Cement Content

Cement content not including fly ash and ground granulated blast furnace slag in excess of 450 kg/m^3 shall not be used as specified in IS 456.

A-2.7 Chloride in Concrete

Whenever there is chloride in concrete there is an increased risk of corrosion of embedded metal. The total amount of chloride content (as Cl) in the concrete at the time of placing shall be as given in Table 7 of IS 456.

A-2.8 Sulphate in Concrete

Excessive amounts of water-soluble sulphate present in the mix constituents can cause expansion and disruption of concrete. To prevent this, the total water-soluble sulphate content of the concrete mix, expressed as sulphuric anhydride (SO_3) shall not exceed 4 percent by mass of the cement in the mix, as specified in IS 456.

ANNEX B

(*Foreword*)

COMMITTEE COMPOSITION

Cement and Concrete Sectional Committee, CED 02

Organization	*Representative(s)*
In Personal Capacity (*14A, Summer Breeze, Seasons, Kuravankonam, Kowdiar, Thiruvananthapuram 695 003*)	Shri Jose Kurian (***Chairman***)
ACC Ltd, Mumbai	Shri S. A. Khadilkar Shri Raman Sadanand Parulekar (*Alternate*)
Ambuja Cements Limited, Ahmedabad	Shri J. P. Desai Dr Bibekananda Mohapatra (*Alternate*)
Atomic Energy Regulatory Board, Mumbai	Shri L. R. Bishnoi Shri Sourav Acharya (*Alternate*)
Builders' Association of India, Mumbai	Shri Sushanta Kumar Basu Shri D. R. Sekor (*Alternate*)
Building Materials and Technology Promotion Council, New Delhi	Shri J. K. Prasad Shri C. N. Jha (*Alternate*)
Cement Manufacturers' Association, Noida	Shri Rakesh Bhargava Dr S. K. Handoo (*Alternate*)
Central Public Works Department, New Delhi	Shri A. K. Garg Shri Rajesh Khare (*Alternate*)
Central Soil and Materials Research Station, New Delhi	Director Shri N. Siva Kumar (*Alternate*)
Central Water Commission, New Delhi	Director (CMDD) (N&W) Deputy Director (CMDD) (NW&S) (*Alternate*)
Conmat Technologies Private Limited, Kolkata	Dr A. K. Chatterjee Shri Subrato Chowdhury (*Alternate*)
Construction Chemical Manufacturers' Association, Mumbai	Shri Samir Surlaker Shri Nilotpol Kar (*Alternate*)
CSIR – Central Building Research Institute, Roorkee	Shri S. K. Singh Shri Subhash Gurram (*Alternate*)
CSIR – Central Road Research Institute, New Delhi	Shri J. B. Sengupta Shri Satish Pandey (*Alternate*)
CSIR – Structural Engineering Research Centre, Chennai	Dr K. Ramanjaneyulu Dr P. Srinivasan (*Alternate*)
Delhi Development Authority, New Delhi	Shri Laxman Singh Shri Vijay Shankar (*Alternate*)
Engineers India Limited, New Delhi	Shri Rajanji Srivastava Shri Anurag Sinha (*Alternate*)
Department of Science and Technology, Ministry of Science and Technology, New Delhi	Shri Chander Mohan
Gammon India Limited, Mumbai	Shri V. N. Heggade Shri S. C. Upadhyay (*Alternate*)
Hindustan Construction Company Ltd, Mumbai	Shri Satish Kumar Sharma Dr Chetan Hazaree (*Alternate*)
Housing and Urban Development Corporation Limited, New Delhi	Shri Deepak Bansal
Indian Association of Structural Engineers, New Delhi	Shri Mahesh Tandon Shri Ganesh Juneja (*Alternate*)

Organization	*Representative(s)*
Indian Concrete Institute, Chennai	Shri Vivek Naik Secretary General (*Alternate*)
Indian Institute of Technology Delhi, New Delhi	Dr Shashank Bishnoi Dr Supratic Gupta (*Alternate*)
Indian Institute of Technology Madras, Chennai	Prof Devdas Menon Dr Manu Santhanam (*Alternate*)
Indian Institute of Technology Roorkee, Roorkee	Prof V. K. Gupta Dr Bhupinder Singh (*Alternate*)
Indian Roads Congress, New Delhi	Secretary General Director (*Alternate*)
Military Engineer Services, Engineer-in-Chief's Branch, Integrated Headquarters of Ministry of Defence, New Delhi	Maj Gen S. K. Srivastav Shri Man Singh (*Alternate*)
Ministry of Road Transport & Highways, New Delhi	Shri A. P. Pathak Shri A. K. Pandey (*Alternate*)
National Council for Cement and Building Materials, Ballabgarh	Shri V. V. Arora Dr S. Harsh (*Alternate*)
National Test House, Kolkata	Shri Shir Singh Shrimati S. A. Kaushil (*Alternate*)
Nuclear Power Corporation of India Ltd, Mumbai	Shri Arvind Shrivastava Shri Raghupati Roy (*Alternate*)
Nuvoco Vistas Corporation Ltd, Mumbai	Shri Pranav Desai Shri Ravindra Khamparia (*Alternate*)
OCL India Limited, New Delhi	Dr S. C. Ahluwalia
Public Works Department, Government of Tamil Nadu, Chennai	Superintending Engineer Executive Engineer (*Alternate*)
The India Cements Limited, Chennai	Dr D. Venkateswaran
The Indian Hume Pipe Company Limited, Mumbai	Shri P. R. Bhat Shri S. J. Shah (*Alternate*)
The Institution of Engineers (India), Kolkata	Dr H. C. Visvesvaraya Shri S. H. Jain, FIE (*Alternate*)
The Ramco Cements Limited, Chennai	Shri Balaji K. Moorthy Shri Anil Kumar Pillai (*Alternate*)
Ultra Tech Cement Limited, Mumbai	Shri Surya Valluri Dr M. R. Kalgal (*Alternate*)
Voluntary Organization in Interest of Consumer Education, New Delhi	Shri M. A. U. Khan Shri B. Mukhopadhyay (*Alternate*)
In personal capacity (*EA-92, Maya Enclave, Hari Nagar, New Delhi*)	Shri R. C. Wason
In personal capacity (*36, Old Sneh Nagar, Wardha Road, Nagpur*)	Shri L. K. Jain
In personal capacity [*B-806, Oberoi Exquisite, Oberoi Garden City, Goregaon (East), Mumbai*]	Shri A. K. Jain
In personal capacity (*E-1, 402, White House Apartments, R. T. Nagar, Bengaluru*)	Shri S. A. Reddi
BIS Directorate General	Shri Sanjay Pant, Scientist 'F' and Head (Civil Engg) [Representing Director General (*Ex-officio*)]

Member Secretary
Shrimati Divya S.
Scientist 'B' (Civil Engineering), BIS

Concrete Subcommittee, CED 2:2

Organization	*Representative(s)*
In Personal Capacity, (*14A, Summer Breeze, Seasons, Kuravankonam, Kowdiar, Thiruvananthapuram 695 003*)	Shri Jose Kurian (***Convener***)
ACC Limited, Mumbai	Shri Avijit Chaubey
Ambuja Cement Limited, Ahmedabad	Shri J. P. Desai Dr Bibekananda Mohapatra (*Alternate*)
Association of Consulting Civil Engineers (India), Bengaluru	Shri Avinash D. Shirode Shri K. K. Meghashyam (*Alternate*)
Atomic Energy Regulatory Board, Mumbai	Shri L. R. Bishnoi Shri Sourav Acharya (*Alternate*)
Building Materials and Technology Promotion Council, New Delhi	Shri J. K. Prasad Shri Pankaj Gupta (*Alternate*)
Bureau of Design for Hydel and Irrigation Project, Bhopal	Shri S. K. Khare Shri Bhagwati Prasad Gupta (*Alternate*)
Central Public Works Department, New Delhi	Shri A. K. Garg Shri Rajesh Khare (*Alternate*)
Central Soil and Materials Research Station, New Delhi	Shri Rajeev Kumar Shri M. Raja (*Alternate*)
Civil-Aid Technoclinic Pvt Ltd, Bengaluru	Shri M. S. Sudarshan Shri R. Nagendra (*Alternate*)
Creative Design Consultants and Engineers Pvt Ltd, Ghaizabad	Shri Aman Deep
CSIR – Central Building Research Institute, Roorkee	Dr Rajesh Deolia Shri H. C. Arora (*Alternate*)
CSIR – Central Road Research Institute, New Delhi	Shri J. B. Sengupta Shri Satish Pandey (*Alternate*)
CSIR – Structural Engineering Research Centre, Chennai	Dr B. H. Bharath Kumar Dr P. Srinivasan (*Alternate*)
Elkem South Asia Pvt Ltd, Navi Mumbai	Shri Brajesh Malviya Shri Surendra Sharma (*Alternate*)
Engineers India Limited, New Delhi	Shri Rajanji Srivastava Shri Anurag Sinha (*Alternate*)
Department of Science and Technology, Ministry of Science and Technology New Delhi	Dr Chander Mohan
Gammon India Limited, Mumbai	Shri Manish Mokal Shri Sudeesh Rajendran (*Alternate*)
Hindustan Construction Company Ltd, Mumbai	Dr Chetan Hazare Shri Avinash Harde (*Alternate*)
Indian Concrete Institute, Chennai	Shri K. C. Tayade Secretary General (*Alternate*)
Indian Institute of Structural Engineering, Mumbai	Shri D. S. Joshi Shri Hemant Vadalkar (*Alternate*)
Indian Institute of Technology Delhi, New Delhi	Dr B. Bhattacharjee Dr Shashank Bishnoi (*Alternate*)
Indian Institute of Technology Kanpur, Kanpur	Dr Sudhir Mishra
Indian Institute of Technology Madras, Chennai	Dr Manu Santhanam
Indian Institute of Technology Roorkee, Roorkee	Dr Ashok Kumar Jain

Organization	*Representative(s)*
Indian Society of Structural Engineers, Mumbai	Shri D. S. Joshi Shri Hemant Vadalkar (*Alternate*)
Irrigation and Power Research Institute, Amritsar	Chief Engineer (Research) Research Officer (*Alternate*)
Larsen and Toubro Limited, ECC Division, Chennai	Dr B. Sivaram Sarma Shri S. Manohar (*Alternate*)
Military Engineer Services, Engineer-in-Chief's Branch, Integrated Headquarters of Ministry of Defence, New Delhi	Shri S. K. Srivastav Shri Man Singh (*Alternate*)
Ministry of Road Transport and Highways, New Delhi	Shri A. P. Pathak Shri A. K. Pandey (*Alternate*)
National Buildings Construction Corporation Limited, Haryana	Shri H. S. Yadav Shri Pawan Kumar (*Alternate*)
National Council for Cement and Building Materials, Ballabgarh	Shri V. V. Arora Shri P. N. Ojha (*Alternate*)
National Institute of Technology, Warangal	Dr C. B. Kameswara Rao Dr D Rama Seshu (*Alternate*)
Nuclear Power Corporation of India Limited, Mumbai	Shri Arvind Shrivastava Shri N. M. Rao (*Alternate*)
Pidilite Industries Limited, Mumbai	Dr Suguna Naik
Ready Mixed Concrete Manufacturers' Association, Mumbai	Shri Vijaykumar R. Kulkarni Shri Anil Kulkarni (*Alternate*)
Research, Design and Standards Organization (Ministry of Railways), Lucknow	Joint Director (B&S)/CB-I Joint Director (B&S)/CB-II (*Alternate*)
Shapoorji Pallonji and Company Private Limited, Mumbai	Shri Girish Bonde Shri D. N. Vishwanath (*Alternate*)
Tandon Consultants Private Limited, New Delhi	Shri Mahesh Tandon Shri Vinay Gupta (*Alternate*)
Tata Consulting Engineers Limited, Mumbai	Shri S. N. Diwakar Shri Manos Kumar De (*Alternate*)
Ultra Tech Cement Limited, Mumbai	Dr V. Ramachandra Dr A. K. Singh (*Alternate*)
Water Resource Department (Government of M.P.), Mumbai	Shri S. K. Khare Shri B. P. Gupta (*Alternate*)
In personal capacity (*452, Sector-14, Sonipat, Haryana*)	Shri R. K. Jain
In personal capacity (*36 Old Sneh Nagar, Wardha Road, Nagpur*)	Shri Lalit Kumar Jain
In personal capacity [*B-806, Oberoi Exquisite, Oberoi Garden City, Goregaoin (East), Mumbai*]	Shri A. K. Jain
In personal capacity (*EA-92, Maya Enclave, Hari Nagar, New Delhi*)	Shri R. C. Wason
In personal capacity (*M1F1 VGN Minerva Apartments, Guruswamy Road, Nolambur, Chennai*)	Dr C. Rajkumar

Panel for Aggregates from Natural and Other Sources, CED 2:2/P8

Organization	*Representative(s)*
In Personal Capacity, (*14A, Summer Breeze, Seasons, Kuravankonam, Kowdiar, Thiruvananthapuram 695 003*)	Shri Jose Kurian (***Convener***)
Central Public Works Department, New Delhi	Shri M. K. Sharma Shri Mathura Prasad (*Alternate*)
Central Soil and Materials Research Station, New Delhi	Shri N. V. Mohrai
CSIR-Central Building Research Institute, Roorkee	Shri S. K. Singh Shri Subhash Gurram (*Alternate*)
CSIR-Central Road Research Institute, New Delhi	Dr Devesh Tiwari Shri Binod Kumar (*Alternate*)
CSIR-Structural Engineering Research Centre, Chennai	Dr P. S. Ambily Dr P. Srinivasan (*Alternate*)
IL & FS Environment Infrastructure and Services Ltd, New Delhi	Representative
Indian Concrete Institute, Chennai	Shri K. P. Abraham
Indian Metals and Ferro Alloys Ltd, Bhubaneshwar	Shri Ashok Kumar Behera Shri Pradipto Dey
JSW Cement Ltd, Mumbai	Shri S. M. R. Prasad Shri D. Satish Kumar (*Alternate*)
Military Engineer Services, Engineer-in-Chief's Branch, Integrated Headquarters of Ministry of Defence, New Delhi	Brig Girish joshi Lt Col Gaurav Kaushik (*Alternate*)
National Council for Cement and Building Materials, Ballabgarh	Shri V. V. Arora Shri Amit Trivedi (*Alternate*)
NETRA – NTPC Ltd, Noida	Dr M. Malik Shri G. P. Yadav (*Alternate*)
Ready Mixed Concrete Manufacturers' Association, Mumbai	Shri V. R. Kulkarni Shri Ravishankar (*Alternate*)
Sesa Sterlite – Sterlite Copper, Tuticorin	Representative
Tata Steel Limited, Jamshedpur	Representative
In personal capacity (*Type IV/17, President Estate, New Delhi*)	Shri K. H. Babu
In personal capacity (*EA-92, Maya Enclave, Hari Nagar, New Delhi*)	Shri R. C. Wason

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act*, 2016 to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Copyright

BIS has the copyright of all its publications. No part of these publications may be reproduced in any form without the prior permission in writing of BIS. This does not preclude the free use, in the course of implementing the standard, of necessary details, such as symbols and sizes, type or grade designations. Enquiries relating to copyright be addressed to the Director (Publications), BIS.

Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards: Monthly Additions'.

This Indian Standard has been developed from Doc No.: CED 02 (11363).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones: 2323 0131, 2323 3375, 2323 9402 *Website*: www.bis.gov.in

Regional Offices:		*Telephones*
Central	Manak Bhavan, 9 Bahadur Shah Zafar Marg NEW DELHI 110002	2323 7617 2323 3841
Eastern	1/14 C.I.T. Scheme VII M, V.I.P. Road, Kankurgachi KOLKATA 700054	2337 8499, 2337 8561 2337 8626, 2337 9120
Northern	Plot No. 4-A, Sector 27-B, Madhya Marg CHANDIGARH 160019	265 0206 265 0290
Southern	C.I.T. Campus, IV Cross Road, CHENNAI 600113	2254 1216, 2254 1442 2254 2519, 2254 2315
Western	Manakalaya, E9 MIDC, Marol, Andheri (East) MUMBAI 400093	2832 9295, 2832 7858 2832 7891, 2832 7892

Branches : AHMEDABAD. BENGALURU. BHOPAL. BHUBANESHWAR. COIMBATORE. DEHRADUN. DURGAPUR. FARIDABAD. GHAZIABAD. GUWAHATI. HYDERABAD. JAIPUR. JAMMU. JAMSHEDPUR. KOCHI. LUCKNOW. NAGPUR. PARWANOO. PATNA. PUNE. RAIPUR. RAJKOT. VISAKHAPATNAM.

Published by BIS, New Delhi